Mid-Frequency Shallow Water Studies and SW06 (LEAR)

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LONG-TERM GOALS

To develop a basis for the Navy to make decisions on what environmental parameters to measure, to what spatial and temporal scale they should be measured, and how to best select frequencies for sonar design. Emphasis is on the mid- to high-frequency range defined as frequencies nominally between 1 and 20 kHz.

OBJECTIVES

The primary objective this year was to complete the initial analysis of the LEAR (Littoral Environmental Acoustics Research) experiment that was conducted in August 2006 in collaboration with Dajun Tang of APL-UW and other Shallow Water 06 (SW06) participants.

APPROACH

The main item of experimental instrumentation, the Moored Receiving Array (MORAY 1+) included a horizontal line array, in addition to its two vertical line arrays, and focus this year was on the initial data evaluation of measurements obtained with this system (Fig. 1). These measurements were obtained at precise stations (Fig. 2), that allowed for the sampling of acoustic propagation effects at different ranges and directions with respect to the MORAY 1+.

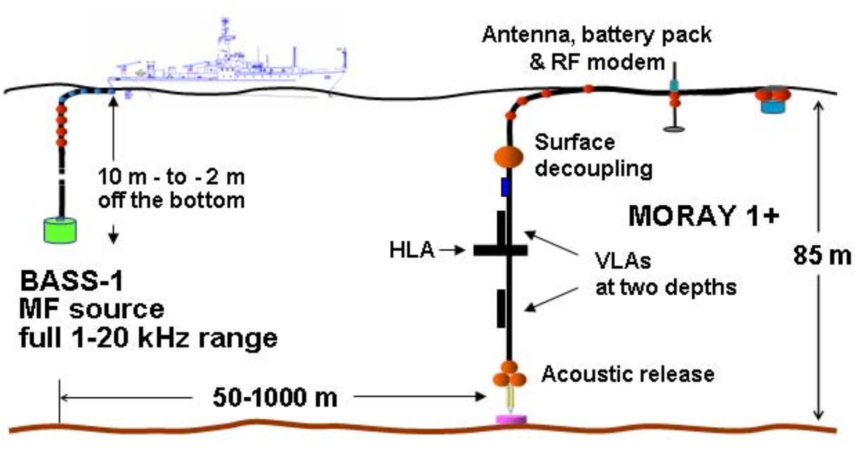

Figure 1. MORAY 1+ (Moored Receiving Array) and the BASS-1 source as deployed from the R/V Knorr during SW06.

Report Documentation Page

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14. ABSTRACT
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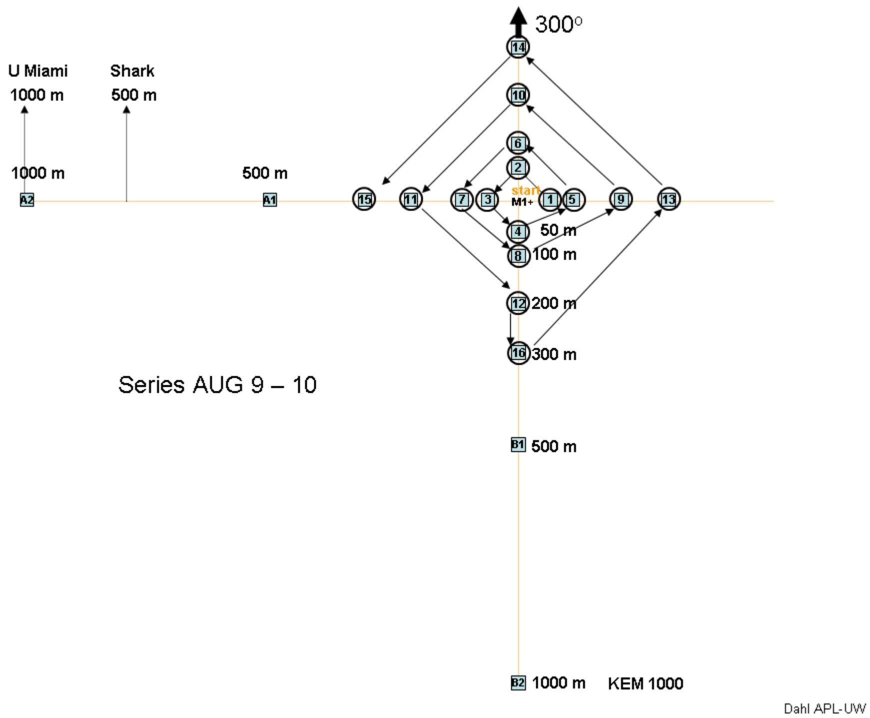

Figure 2.Location of the MORAY 1+ (M1+ in center of figure) with respect to the 20 acoustic transmission stations that were involved in the Aug 9-10 measurements. Each transmission station represents the precise location of the stern of the R/V Knorr (from which the APL-UW acoustic source was suspended.) Other experimental days involved some or all of these same stations. The direction of 300^o is noted.

WORK COMPLETED

The work completed involved two lines of inquiry: one on the analysis of seabed reflection as a function of bottom grazing angle, frequency, and direction, and the other on the analysis of vertical spatial coherence.

Results were discussed at the Acoustical Society of America meeting in December 2006, and at the SW06 workshop in San Diego in January 2007, and are subjects of manuscripts in preparation.

RESULTS

Figure 3 shows estimates of bottom loss as function of frequency, grazing angle, and direction as (defined in Fig. 2.) The red and blue curves represent two, preliminary models for the data that are currently being investigated. Additional measurements representing frequencies up to a maximum of 20 kHz are currently being analyzed. Upon completion of this analysis, an inversion of the data for geoacoustic parameters will be undertaken with results compared with ground truth measurements taken at the site.

Figure 4 shows vertical spatial coherence measured on the upper, and lower, VLAs of the MORAY 1+ at a range of 200 m. These measurements represents a steady-state, whole-channel estimate of

coherence, for which all ray paths (Fig. 5) are contributing. A model (solid line) for the data is developed based on the superposition of such paths.

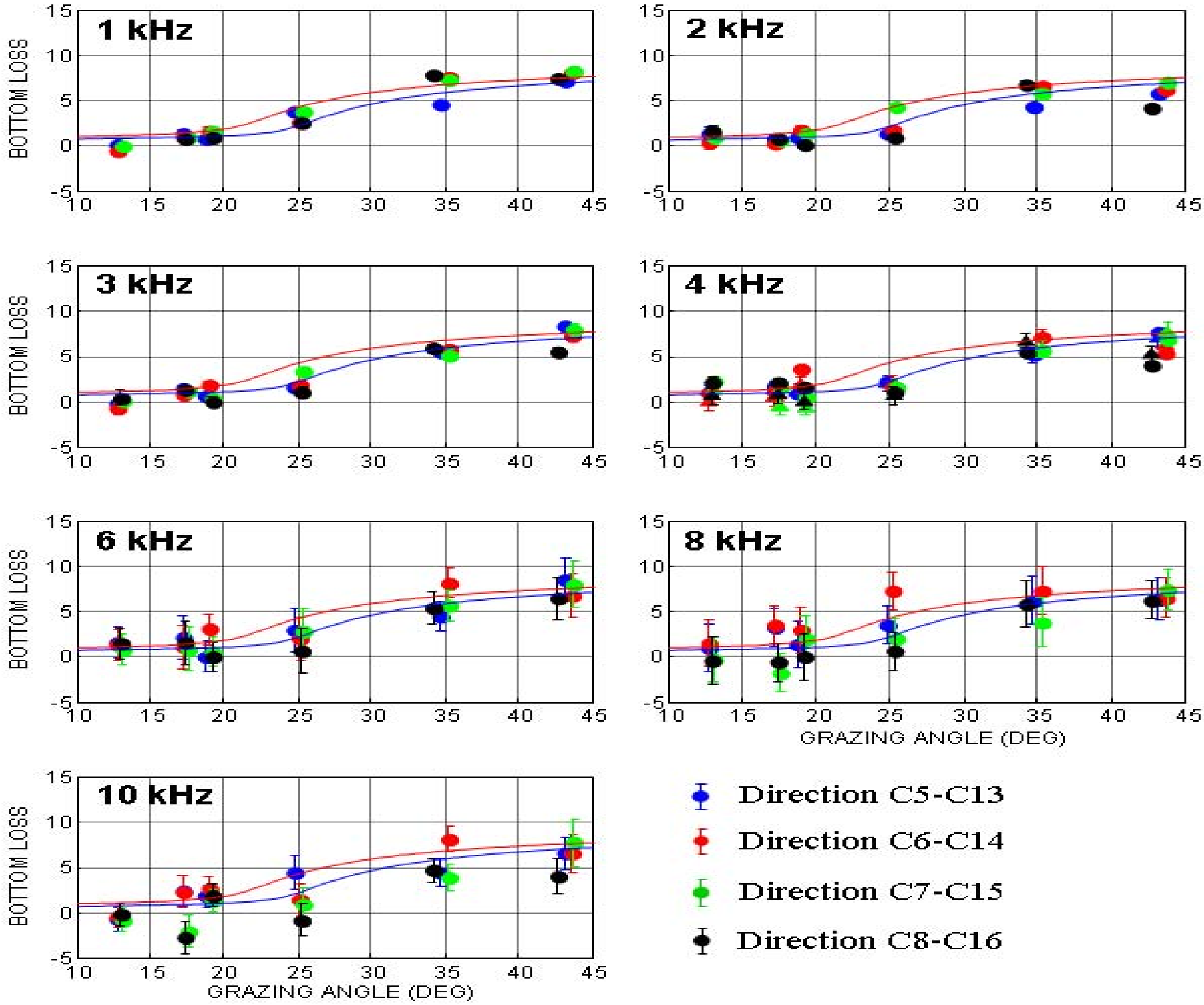

Figure 3. Estimates of bottom loss as a function of frequency, grazing angle, and direction. Directions refer to the station geometry as shown in Fig. 2. Red and blue curves represent two, preliminary models for the data.

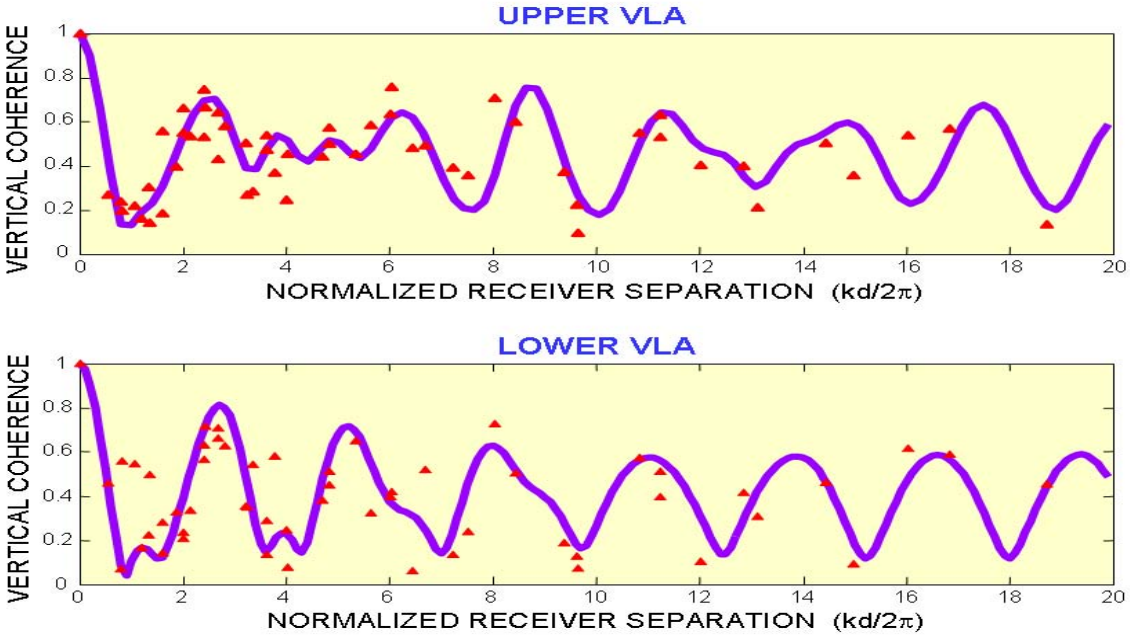

Figure 4. Vertical spatial coherence as measured on the upper and lower MORAY 1+ vertical line arrays (VLA). Red symbols represent data estimates plotted as function of normalized receiver separation, and solid lines represent a model of these data.

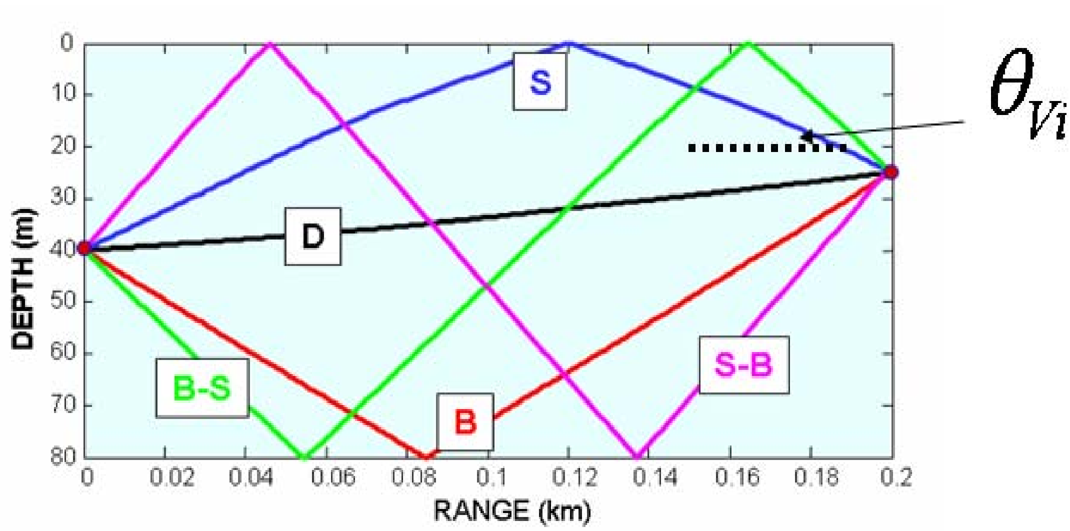

Figure 5. Ray diagram showing principal eigenrays between source and upper VLA. These eigenrays represent the direct path (D), surface bounce path (S), bottom bounce path (B), surface-bottom bounce paths (S-B), and bottom-surface bounce path (B-S). The vertical arrival angle of the surface path is identified.

IMPACT/APPLICATIONS

The SW06/LEAR data set, with its emphasis on simultaneous, co-located environment and acoustic measurements, will assist the Navy in making rational decisions on what environmental parameters to measure, to what spatial and temporal scale they should be measured, and how to best select frequencies for sonar design.

RELATED PROJECTS

This research is integrated together with those from several PIs involved in the SW06/LEAR program.

PUBLICATIONS

P. H. Dahl and J. W. Choi, "Spatial coherence of the Acoustic Field", presented at the 152nd meeting of the Acoustical Society of America, Honolulu, HI, December 2006 (abstract)

P. H. Dahl, J. W. Choi and D. Dall'Osto "Properties of the non-propulsive ship noise field as measured from a research vessel holding station in the Yellow Sea and relation to sea bed parameters", presented at the 1st Pacific Rim Underwater Acoustics meeting, Vancouver, B.C., September 2007.